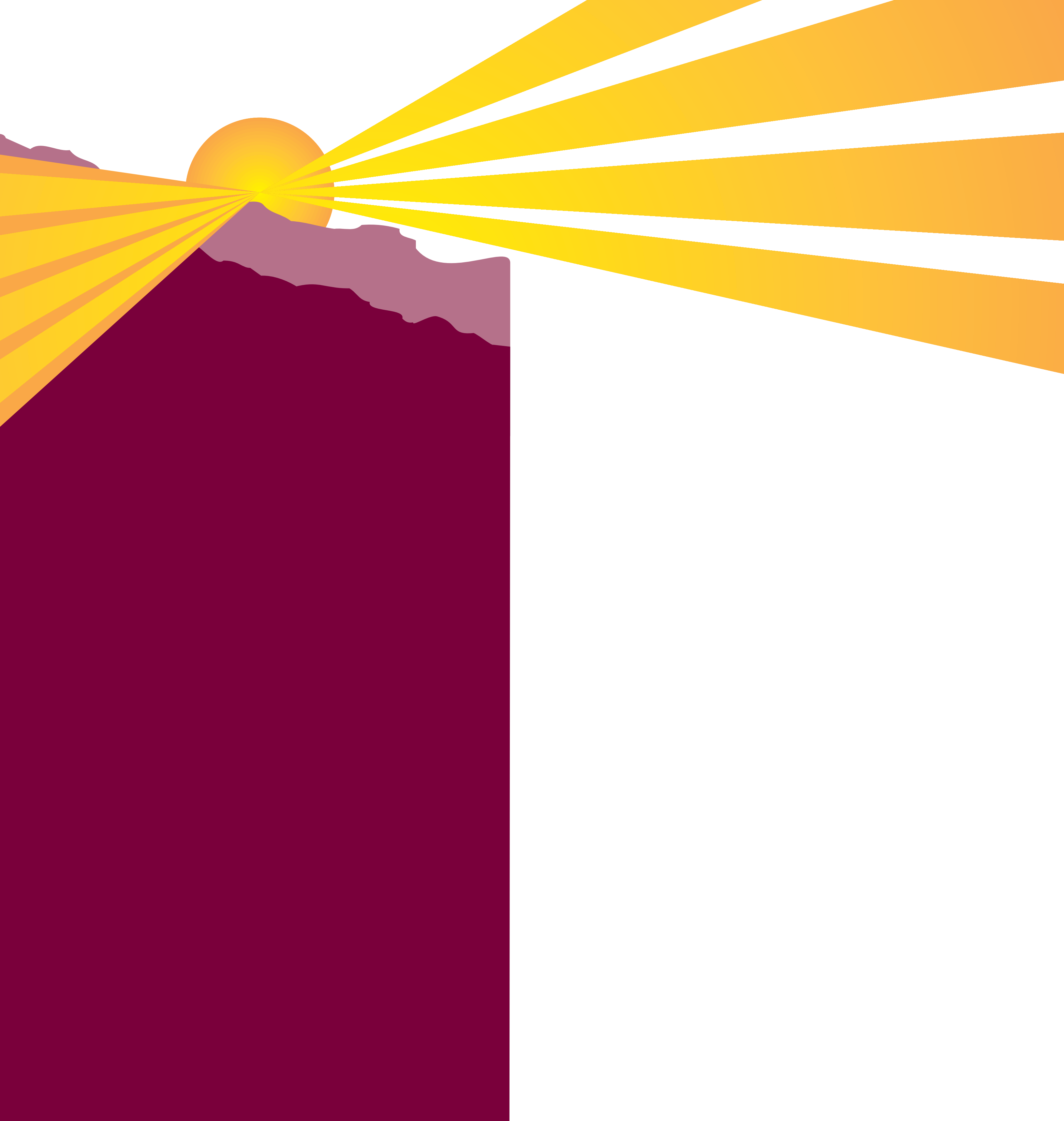


CONCENTRATING SOLAR POWER

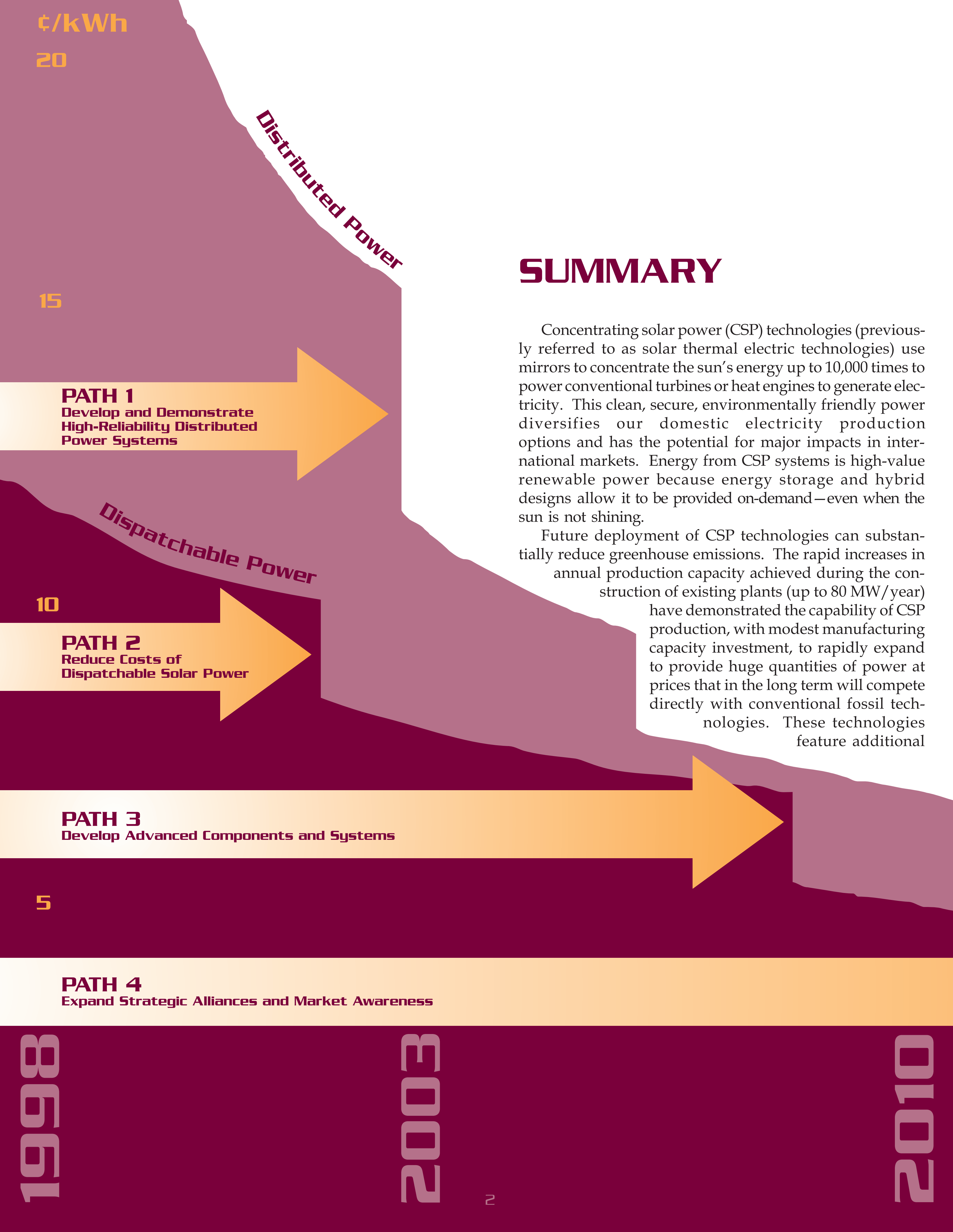
Paths to the Future

Five-Year Program Plan
1998-2003

SUMMARY

Concentrating solar power (CSP) technologies (previously referred to as solar thermal electric technologies) use mirrors to concentrate the sun's energy up to 10,000 times to power conventional turbines or heat engines to generate electricity. This clean, secure, environmentally friendly power diversifies our domestic electricity production options and has the potential for major impacts in international markets. Energy from CSP systems is high-value renewable power because energy storage and hybrid designs allow it to be provided on-demand—even when the sun is not shining.

Future deployment of CSP technologies can substantially reduce greenhouse emissions. The rapid increases in annual production capacity achieved during the construction of existing plants (up to 80 MW/year) have demonstrated the capability of CSP production, with modest manufacturing capacity investment, to rapidly expand to provide huge quantities of power at prices that in the long term will compete directly with conventional fossil technologies. These technologies feature additional



advantages of providing quality manufacturing jobs for local economies and export markets for key components.

This Five-Year Program Plan describes the next steps in technology research, development, and field validation required for CSP technologies to make a major contribution to clean global energy resources in the years to come.

The figure below illustrates the decreases in levelized energy cost needed for competitiveness in broad markets in the future. This plan consists of four paths, shown graphically as overlays on the figure, to achieve this competitiveness. The first path, ***Develop and Demonstrate High-Reliability Distributed Power Systems,*** focuses on reliability of dish/engine systems for emerging markets for distributed energy sources. Efforts on this path address the technology improvements needed to field more competitive next-generation systems. The efforts will result in orders of magnitude improvements in system reliability and also will achieve energy costs in the range of 9 to 11¢/kWh in about five years. The second path, ***Reduce Costs of Dispatchable Solar Power,*** addresses the highest priority activities required to bring power tower and commercially proven trough technologies to early dispatchable power markets. Accompanied by early demonstrations supported by both green power markets and multilateral organizations like the Global Environment Facility, this development effort will lead to a "next generation" of plant designs capable of producing dispatchable power for 6 to 8¢/kWh within the time frame of this plan.

Penetration of broad domestic and international mega-markets will, however, require further significant technology advances that we address in Path 3, ***Develop Advanced Components and Systems.*** Coupled with economies-of-scale emerging from continued expansion into high-value markets, the advanced technologies resulting from this path will allow CSP systems to compete in large-scale distributed and dispatchable markets priced at 4 to 6¢/kWh. At these prices, U.S. industry will ultimately be able to achieve our strategic target of 20 GW by 2020.

In parallel with these three major technology paths, we will also pursue a fourth, ***Expand Strategic Alliances and Market Awareness.*** This path will keep our technology efforts focused on the most critical needs of industry, ensure a technology capable of meeting market requirements, and support domestic and international information flow and policy decisions favorable to renewable energy.

The remainder of this document outlines the specific requirements of the distributed and dispatchable power markets toward which the technology is targeted, and then defines the four paths in detail.

Meeting our goals will be a challenge. We believe, however, that the combined capabilities of the Department of Energy (DOE), Sandia National Laboratories and the National Renewable Energy Laboratory (working together as SunLab), and U.S. industry are up to that challenge, and hence that CSP can become a major source of clean, reliable, and secure power in the future.

Concentrating Solar Power
Levelized Energy Cost Projections

2020

The Markets

Distributed Power Applications

The current CSP emphasis on distributed power applications is to develop technologies that can operate reliably for loads ranging from 10 kW_e to several MW_e. The majority of these applications are currently for remote power (such as water pumping and village electrification) where there is no utility grid. In these applications, diesel engine generators are the primary current competition to CSP. Of growing interest to a number of utilities are domestic grid-connected applications in which the system is sited at critical points on the transmission and distribution (T&D) system, providing value not simply from the energy produced but also in offsetting T&D losses and postponing the need to upgrade the T&D infrastructure to meet load growth. Small gas-turbine systems will also compete with CSP and other renewable energy technologies for this market. Key market criteria for distributed power applications are reliable unattended operations, minimal (and low technology) service requirements, and competition with the cost of alternatives (which are typically quite high).

The CSP technology thrust for distributed applications is the dish/engine system. Each dish/engine module (10 to 50 kW, depending on the design) is an independent power system designed for automatic startup and unattended operation. Multiple dish/engine systems can be installed at a common site to provide as much power as required, and the system can easily be expanded with additional modules to accommodate future load growth. The systems can be designed for solar-only applications, can be easily and cost-effectively hybridized with fossil fuels to allow power production without sunlight, or can be deployed with battery systems to store energy for later use. The high value of distributed power (as high as 50¢/kWh and above for some remote applications) provides ample opportunities for commercial deployment early in the technology development.

There are several critical issues facing the development of dish/engine systems. The first and foremost is reliability, as measured by both Mean Time Between Failure (MTBF) and operation and maintenance (O&M) costs. The second issue is system cost, although this issue is currently less critical because commercial sales will occur in high-value markets at current costs if reliability and O&M are improved.

The future for distributed CSP applications appears bright. The technology enhancements necessary to achieve high reliability and reduce O&M costs are well understood. As technology development proceeds, there will be numerous opportunities for field validations that will build on the high value of energy for remote applications and the low cost for system demonstration (because of the small module size). The figure to the right summarizes the opportunities and energy costs needed to realize them.

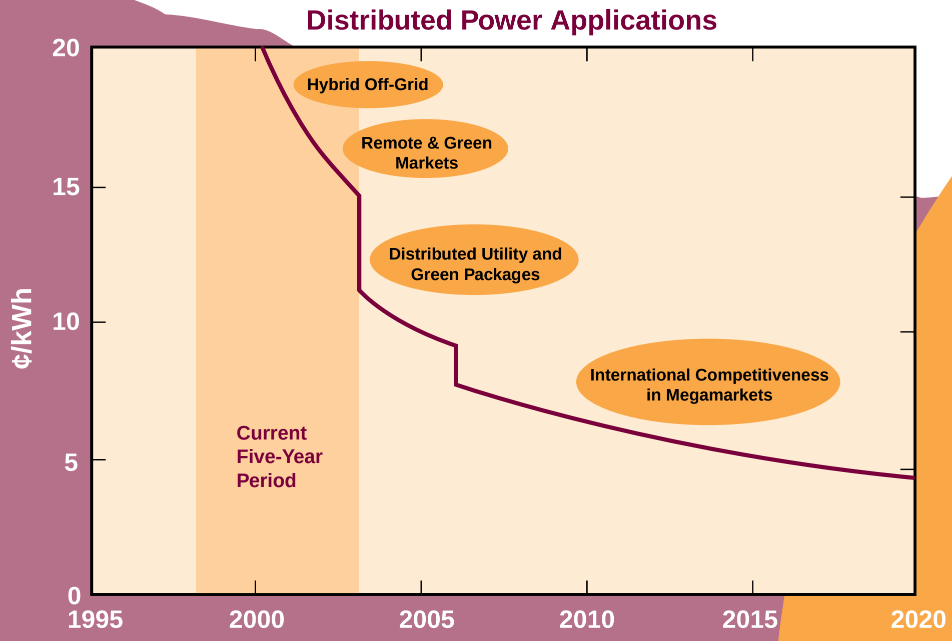
Dispatchable Power Applications

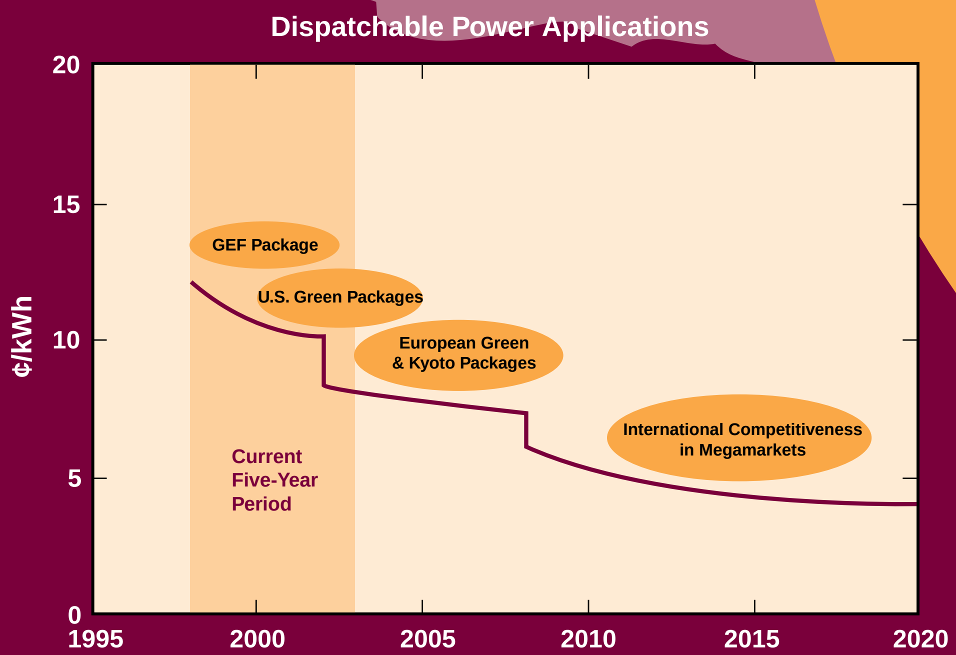
Dispatchable power markets are dominated by fossil-fuel-fired electricity distributed over central utility grids. Power must be produced "on demand" in order to meet changing loads and command the highest value. Low life-cycle costs are the primary driver for investment decisions in this market, and gas-fired combustion turbines and combined-cycle power plants represent tough competition for CSP technologies.

Using storage and hybridization capabilities, dispatchable CSP trough and power tower technologies currently offer the lowest-cost, highest-value solar electricity available and have the potential to be economically competitive with fossil energy in the longer term. These systems exhibit economies-of-scale like more conventional power plants, with unit costs declining for larger plant sizes. The lowest energy costs are generally achieved in the 100 MW and greater size range, although more modular designs (30 MW and below) are feasible and may offer advantages in some applications.

CSP technologies face a number of challenges in meeting developer, investor, and customer needs. The most significant challenge in dispatchable applications is that the levelized energy cost (LEC) is currently higher than competing conventional technologies. Technology enhancements described in this plan will help reduce the capital cost of solar components and enable higher annual efficiency (both leading to lower LEC). Furthermore, advanced system development will lead to substantial cost reductions through innovative designs, advanced materials, and improved operations. Additional development of hybrid systems will enable increased modularity, reduced risk, and reduced cost.

CSP systems are currently candidates for dispatchable applications in major international markets. In addition, high-value domestic markets, such as green markets like the proposed Arizona Portfolio Standard, may provide openings for early commercial plants or technology validations. In the long term, the development of power parks, both domestically and internationally, will reduce costs through economies-of-scale and further help the technology grow. These market opportunities, as well as the energy costs required by the technology to enter these markets, are summarized in the figure to the right.





THE PATHS FORWARD

Our objective with this plan is to develop and validate concentrating solar power technologies that meet the needs of the marketplace. Building on the success established to date, we expect to make significant progress during the next five years by focusing on four key paths:

Path 1. Develop and demonstrate high-reliability distributed power systems.

Path 2. Reduce costs of dispatchable solar power.

Path 3. Develop advanced components and systems.

Path 4. Expand strategic alliances and market awareness.

Each of these paths is discussed in detail in the remainder of this document.

Path 1

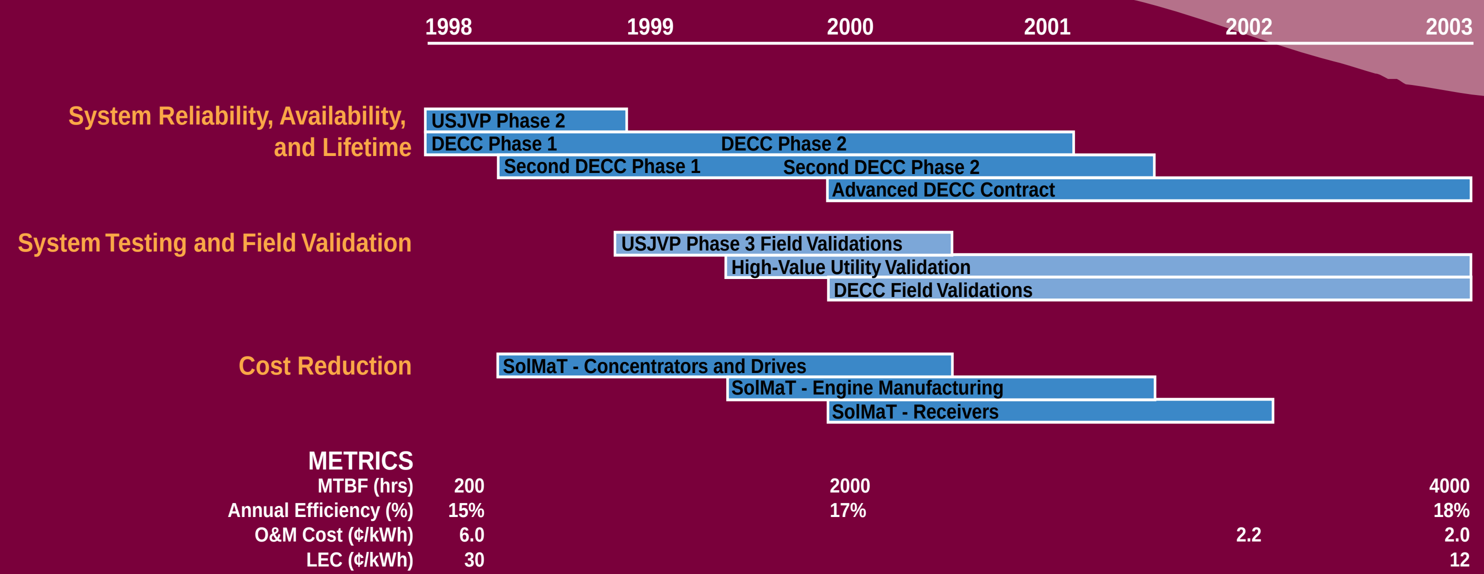
Develop and Demonstrate High-Reliability Distributed Power Systems

Our primary goal in this path is to achieve significant improvements in the reliability of U.S.-manufactured distributed CSP systems. During the next five years, we will develop these systems to be the most reliable products of their type in the world and will verify this reliability through a series of field validations. The reliability and operating characteristics proven in the field will provide the critical data required by investors and end users prior to early commercial introduction of the technology. Significant reductions in the cost of the technology will also occur during this time but will be pursued as a secondary objective relative to establishing market-ready reliability.

We will measure our progress in this area through two metrics: reliability and energy cost. Reliability, measured by system MTBF, will be assessed on developmental prototype units but later will be evaluated in field demonstrations with sufficient units to develop statistically valid reliability projections. Energy cost will be measured using LEC calculations for typical independent power producer project ownership. The LEC metric incorporates the impact of improved reliability as well as reductions in the system capital cost and O&M costs.

System Reliability, Availability, and Lifetime

Activities in this task are aimed at developing components that improve the key operating characteristics of distributed power systems: reliability,



availability, and lifetime. The development cycle includes initial design efforts, bench and field testing, and integration of components into complete systems. The majority of the activities are conducted in conjunction with industry teams that are cost-sharing the technology development. The current major project in this area is the Utility-Scale Joint Venture Program (USJVP), the objective of which is to develop manufacturable 25-kW dish/Stirling systems ready for commercial demonstration. The project cost is shared on a 50-50 basis by industry and DOE. The next USJVP project milestone will result in the testing of five to eight "second generation" system designs that show significantly improved reliability and availability compared to the first generation system built by the team.

Another system-level effort led by industry teams is the Dish/Engine Critical Components (DECC) Project. The objective of this effort is to develop alternative components for the "solar critical" parts of a dish/engine system to provide technology options and diversify the applications that can be served by U.S. industry. The current projects in this area include cost-shared development of solar dish systems using Brayton- and Stirling-cycle heat engines. Early work will solarize and test these engines, with follow-on activities aimed at integrating the engines into complete systems. We will develop additional, similar contracts under the DECC Project in the future.

Component research and development (R&D) is very important in improving operating characteristics of distributed power systems, and this R&D is carried out within the USJVP, the DECC projects, and SunsLab laboratory activities. Engine reliability is currently a critical issue, with industry working to develop enhanced solar designs and DOE activities focused on validating engine operations in field testing and diagnosis of problem areas. Another critical development area is the receiver, which must provide high-efficiency conversion of sunlight into heat while operating for years in a very high solar flux environment. Current efforts emphasize developing new receivers for higher efficiency operation (primarily liquid metal heat-pipe receivers) while resolving materials and fabrication problems that have limited the lifetime and reliability of the prototype units tested to date. An important aspect of the advanced receiver development work is the option for receiver hybridization, which will allow operation of the system using either solar energy or fossil fuels. Hybrid operations are highly valued for some distributed power applications because they allow for reliable system operation regardless of time of day or solar conditions.

Science Applications International Corporation (SAIC) USJVP system.

System Testing and Field Validation

Proving the reliability in distributed power systems requires data on how the systems operate in situations that replicate commercial applications. This process is carried out through progressive testing and field validation of systems. System testing for the USJVP will be conducted on five to eight units (a relatively small number) at selected locations to evaluate system operation and response to environmental conditions (solar insolation, clouds, wind, temperature, etc.). Once systems have passed their design hurdles in system testing, they will be deployed in field validation projects to simulate the operating conditions of actual commercial applications, including less operator attention than field testing. In the validation of the USJVP system, the objective will be to gather operating data on a number of units to allow statistically valid projections of

"... commercial sales will occur in high-value markets at current costs if reliability and O&M are improved."

the systems' operating characteristics (such as MTBF, annual maintenance costs, and availability). These projects are progressive: testing leads to deployment of improved designs in field validation, field validations identify essential design improvements, and design improvements lead to a new cycle of testing and validation.

Cost Reduction

Cost reduction activities for near-term markets will become a significant program element after critical reliability targets have been met, probably beginning in fiscal year 2000. Efforts in cost reduction will build on the successes of the Solar Manufacturing Technology (SolMaT) initiative, which is focused on developing designs and manufacturing techniques appropriate for low-volume markets associated with the early phases of commercial development. Early targets for cost reduction exist in the engine; concentrator drive, facets, and structure; and receiver.

Stirling Thermal Motors Stirling power conversion unit.

Path 2

Reduce Costs of Dispatchable Solar Power

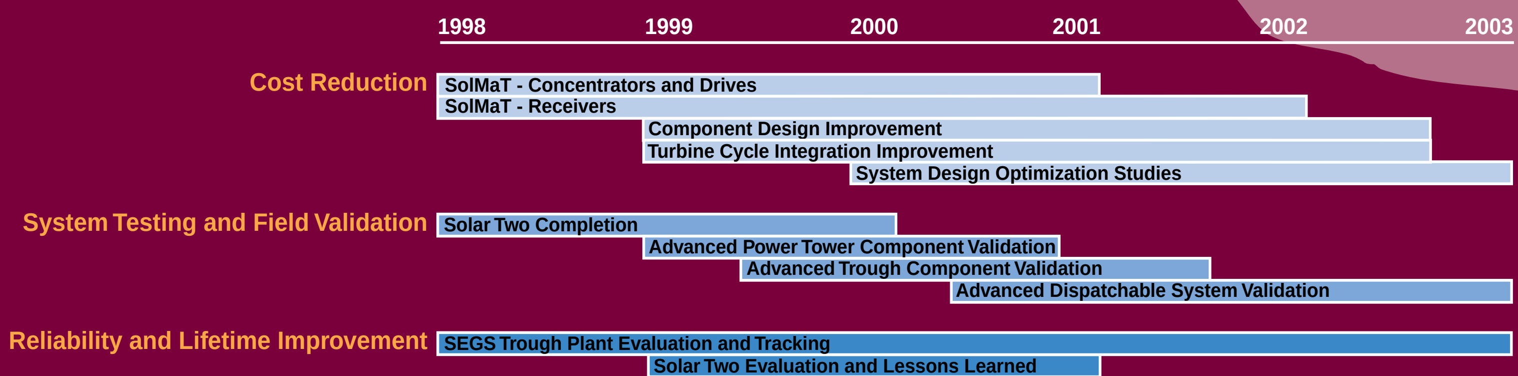
Low energy costs are the overriding criteria in the dispatchable power market, and this path focuses on reducing the LEC of dispatchable solar power. This focus recognizes that while there will be market preferences for renewable electricity such that "green electricity" can be sold at a premium price, the price will still be the most important issue for success in this market. The outcome from this work will be substantial decreases in the LEC of dispatchable power systems. While the systems will not compete broadly with fossil technologies in five years, they will make progress toward substantial commercial deployment in niche markets and be fully competitive with fossil fuels in the longer term.

For dispatchable CSP applications, the LEC is driven by project financing costs, the capital investment and net efficiency of the plant, plant availability, and operating costs. Our emphasis in this path focuses on technology aspects under our control: reducing the cost of solar components, reducing technical risk through system testing and field validation, and reducing O&M costs.

Cost Reduction

The greatest current driver of the LEC for dispatchable solar power is the cost of solar components. The purchase price of solar concentrators alone constitutes 40 to 50% of the LEC of the plant. High prices are not an inherent characteristic of CSP, but rather are reflections of prototype production methods, immature component designs, and nonoptimal system configurations. All these factors can be improved in the near term.

Designing better production methods for solar components will continue in the SolMaT initiative. SolMaT works hand-in-hand in cost-shared collaborations with U.S. industry to improve the manufacturing processes for solar-specific components. SolMaT addresses the gap that exists between the potential for low costs in mass production and the current reality of uncertain



METRICS	1998	1999	2000	2001	2002	2003
Capital Cost ($/kW)	4000			3500		3000
Annual Efficiency (%)	12%					15%
O&M Cost (¢/kWh)	3.0				2.2	2.0
LEC (¢/kWh)	12					8

orders for modest production levels. SolMaT activities for solar components typically begin with a Design for Manufacturing and Assembly analysis, followed by modifications to component design and the component manufacturing process. The end result of SolMaT studies are solar components that can be produced and sold for less money without the need to rely on large production levels. Side benefits of the process can include improved performance and lifetime through better design and/or quality control in manufacturing.

During the next five years, SolMaT activities will focus on the highest-cost, most-critical elements of CSP systems. A major focus will continue to be reducing the costs of concentrators for troughs and towers (including reflective surfaces, mirror modules, drives, and structures). We will also continue cost reduction activities that address receiver manufacturing issues.

Opportunities also exist to reduce component costs through design improvements. Although several generations of designs have been developed for some components used in trough systems, there are still opportunities for improvement. In the case of power towers, many of the advanced components are still in the development stage. Design enhancements will build on learning from pilot projects, field validations, and commercial projects to identify the most promising areas for cost reduction. Efforts for the coming few years will focus on additional work on new receivers and new concentrator designs, where emphasis is placed on high performance and cost effectiveness.

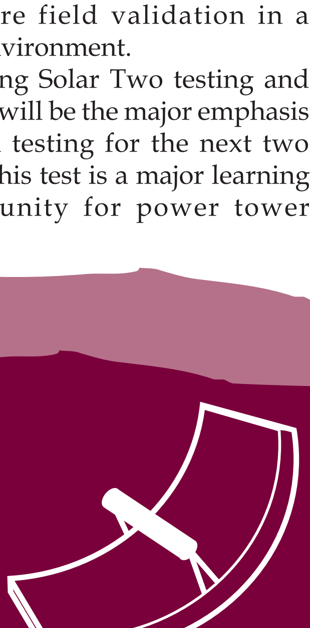
A final opportunity for near-term cost reduction lies in the area of system design and optimization. One of the most exciting prospects is the investigation of new hybrid solar/fossil cycles, which combine current CSP technology with recent advances in gas-turbine and combined-cycle plants. The higher efficiency of the power cycles in these plants results in lower cost solar electricity, and amortizing plant capital costs during fossil operations also works to substantially reduce the solar energy cost. Additional opportunities in this area include better management of plant parasitics and operation, and better matching of the solar field output to existing turbines. Initial activities will consist of conceptual design studies that identify the best options for substantial cost reduction with minimal technical and commercialization risks.

Kramer Junction SEGS plant.

System Testing and Field Validation

System testing and field validation are both very important in moving toward new commercial applications of dispatchable CSP technology. The magnitude of the capital required for a commercial plant makes investors averse to deployment of any technology that is not well proven. The solar electric generating systems (SEGS) trough plant designs have crossed this hurdle, but newer trough technology will require field experience prior to major commercial acceptance. Power tower technology is currently undergoing system tests necessary before field validation in a commercial environment.

Completing Solar Two testing and evaluation will be the major emphasis in system testing for the next two years. This test is a major learning opportunity for power tower



technology and will help drive decisions about future technology directions for power towers. Solar Two operations will prove the annual efficiency of the plant at a pilot-plant scale and will demonstrate reliability of power tower technology and the ability to use energy storage to meet utility loads during periods without sun.

A new activity taking shape in the next few years is testing improved trough components at SunsLab facilities and at an operating trough plant such as Kramer Junction. The SunsLab tests will provide detailed information on the performance characteristics of the components, while tests at the plant sites will answer longer term durability and operations questions. These tests are designed to provide the confidence needed by plant designers and investors to use more advanced trough technology in the next generation of commercial plants.

These system tests will provide decision points for additional tests and/or field validation in future years. Combined with the results of the system design and optimization efforts, new components and systems will emerge that will require field testing toward the end of this five-year period. Decisions on which systems to pursue will be driven by the successes in the initial tests, the needs of the industry, and the potential market.

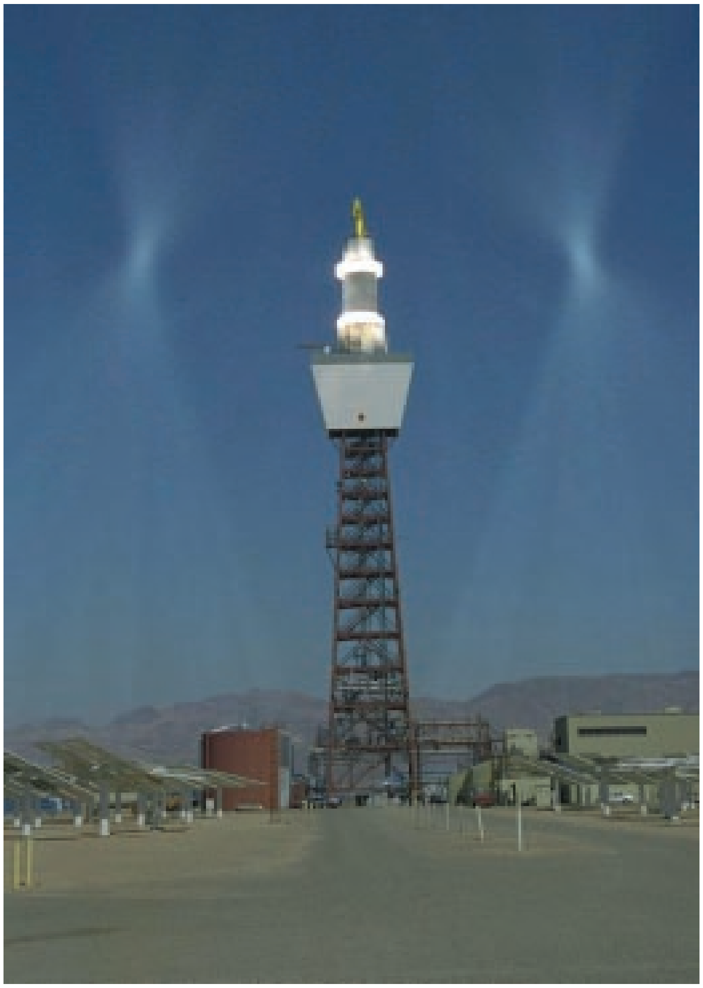
Solar Two receiver.

"Our emphasis in this path focuses on technology aspects under our control: reducing the cost of solar components, reducing technical risk through system testing and field validation, and reducing O&M costs."

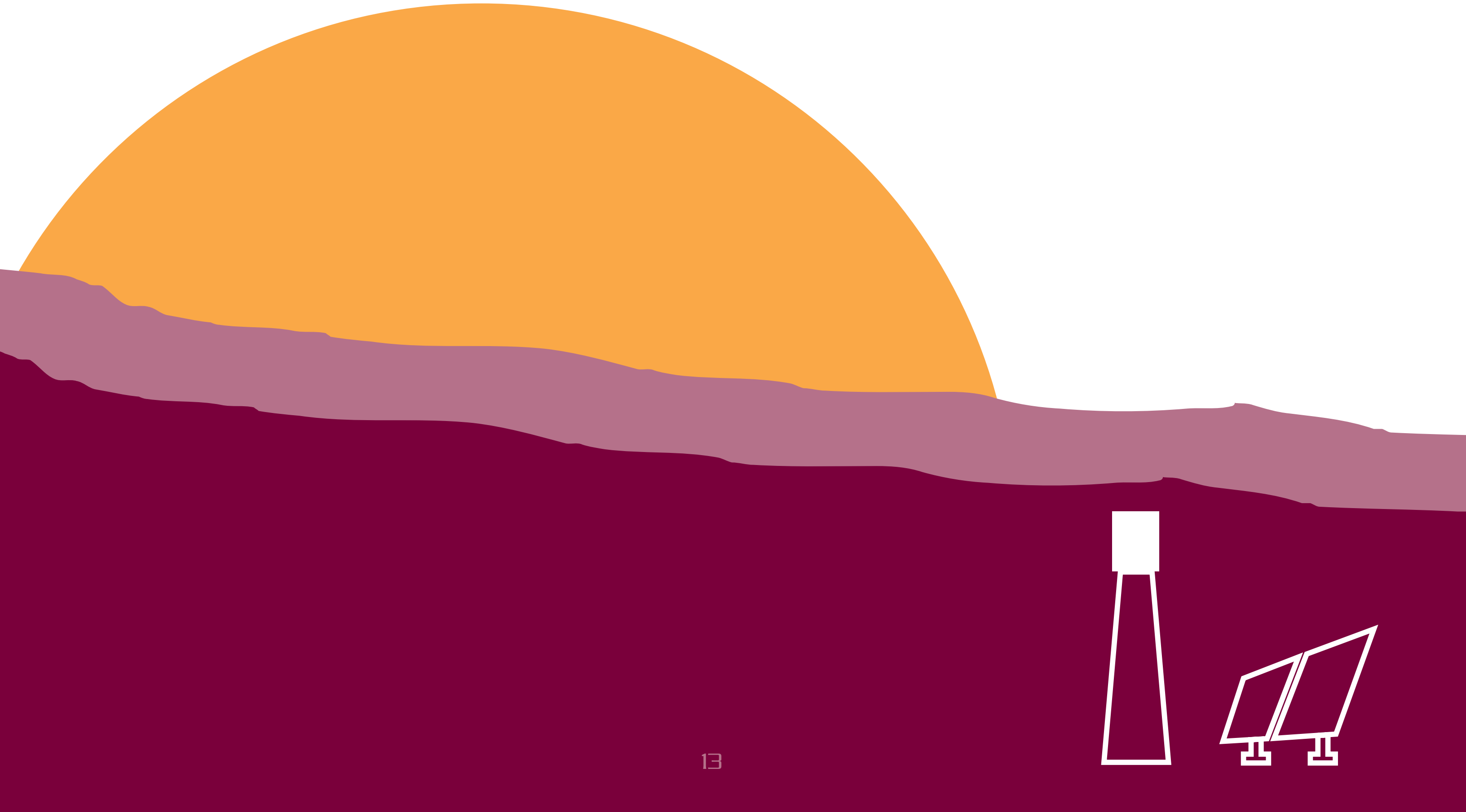
Reliability and Lifetime Improvement

Component reliability and lifetime are important contributors to the annual O&M costs of CSP plants. Component reliability also ultimately establishes the availability of the plant, which affects the annual energy production and plant economics. Ensuring adequate reliability and lifetime for newly developed solar components is an essential step in establishing market-ready technology.

Analysis of the reliability of the Solar Two plant is an important aspect of that project. Plant operating data will be compared to projections from computer models to gain a better understanding of real-world effects on energy production and reliability. Analysis of the Solar Two reliability data will show where plant operations and design can be improved to achieve lower energy costs. In a related activity, we will continue to track implementation of O&M and reliability improvements at existing trough plants. Lessons learned from the trough plant operations are applicable to all CSP technologies.



Solar Two in operation.



Path 3

Develop Advanced Components and Systems

The objective of this path is to develop and validate the advanced technologies that can achieve significant reductions in the future cost of CSP. These technologies are necessary to achieve our long-term strategic goal of competing with the cost of fossil energy in a wide variety of market applications.

High-Efficiency System Designs

Higher conversion efficiencies are one of the primary ways to achieve significant cost reduction and are the focus of much of the work in this area. For distributed applications, receiver improvements offer the chance for a 20% increase in the power produced by the systems with little, if any, increase in the initial cost. In the dispatchable power area, near-term opportunities exist to increase by 20% or more the annual energy delivered by both trough and power tower systems. Work in receiver design, parasitic power reduction, and system design optimization will all contribute to achieving this goal. Technical activities will address, for example, lower melting point salts, new working fluids, new absorber and receiver materials, improved power cycles, and heat exchangers for hybrid systems.

	1998	1999	2000	2001	2002	2003

High-Efficiency System Designs
- Hybrid System Designs and Optimization
- Heat-Pipe Receivers
- Molten-Salt Component Improvements
- Advanced Trough Components
- Advanced Working Fluids

Long-Term R&D
- New Concepts
- Absorber Materials
- Advanced Converter Systems Development
- Volumetric Receivers

Concentrators
- Reflective Materials
- Wind Load Studies
- Advanced Drives
- Structural Facets
- Concentrator Structural Design Optimization

Field Operations
- Mirror-Cleaning Development and Testing
- Communications and Control Systems Development

Systems Analyses
- Tech. Characterizations
- System Modeling and Studies

METRICS

METRICS	1998	2000	2002	2003
Receiver Efficiency (%)	88%			94%
Concentrator Cost ($/m^2)	225			120
MTBF (hrs)	200	2000		4000
O&M Cost (¢/kWh)	6.0		2.2	2.0

Long-Term R&D

Investigations of novel designs for future development is a modest budget item, but is a strategically important aspect of this path. These designs provide the creative foundation for future innovation that may lead to breakthroughs for CSP technology. In this activity, we will investigate advanced concepts at the feasibility analysis and proof-of-principal level. One area of research is the energy conversion device, for which we will investigate advanced concepts that can reduce costs and improve reliability. These devices could eventually replace the engine in distributed power applications. Another example of research in this area is volumetric receiver designs, which are capable of high temperature, high efficiency, and interfacing with advanced heat engines and combined cycles. We will also investigate new system designs, such as high-temperature power towers driving modular combined cycles.

Concentrators

Developing new, low-cost designs for solar components is another way to reduce system costs. Of primary importance is the solar concentrator, which represents 40 to 50% of the cost of the power plant. Better reflective materials, mirror facets, structural designs, and drives are all promising avenues leading toward cost reduction. Reflective materials are a particularly promising long-term option because advanced materials hold promise for not only being cheaper than glass, but for reducing other aspects of concentrator cost by being much lighter in weight and easier to use in manufacturing environments. Field tests of new concentrator designs with analysis of the impacts of wind loads will lead to better design criteria, allowing optimization of concentrator designs and reductions in structural costs.

Field Operations

An important long-term element in achieving low-cost electricity from CSP systems is the construction and operation of the solar collector field. The field must be installed quickly and inexpensively and the collectors aligned to achieve optimum concentration. Control and communication systems must provide for highly reliable collector operations over a period of decades. Ongoing O&M practices, such as mirror cleaning, must be able to keep the collector field operating at high levels of efficiency and availability while also being inexpensive and easy to implement. Improved methods in field installation will be pursued during the next large-scale installation of solar concentrators, either as part of a field validation or a commercial power plant.

Dish receiver testing.

SAIC SolMaT heliostat.

Systems Analyses

Systems analyses activities are conducted to evaluate the status of R&D efforts and to identify promising new directions for technology development. Interfacing with the technology roadmapping efforts described in Path 4 will be one key activity in this area. Systems analyses efforts will also investigate system modeling and optimization, maintaining and updating CSP technology characterizations, and detailed system-level evaluations similar to the Utility Studies and Second-Generation Power Tower Studies completed several years ago.

Path 4

Expand Strategic Alliances and Market Awareness

The objective of this path is to expand alliances with stakeholders who are developing and implementing CSP technologies. Strong alliances with stakeholders are necessary for defining technology, markets, and application requirements for CSP technology. These alliances will support our industry interactions and ensure effective R&D focus and technology transfer.

This path is not a technology path, but it is critical to the successful development and implementation of CSP technologies. Although progress in this path will be difficult to measure quantitatively, we will evaluate (1) the number of partnerships and partners involved in CSP activities and (2) the amount of money industry invests as a fraction of the DOE program.

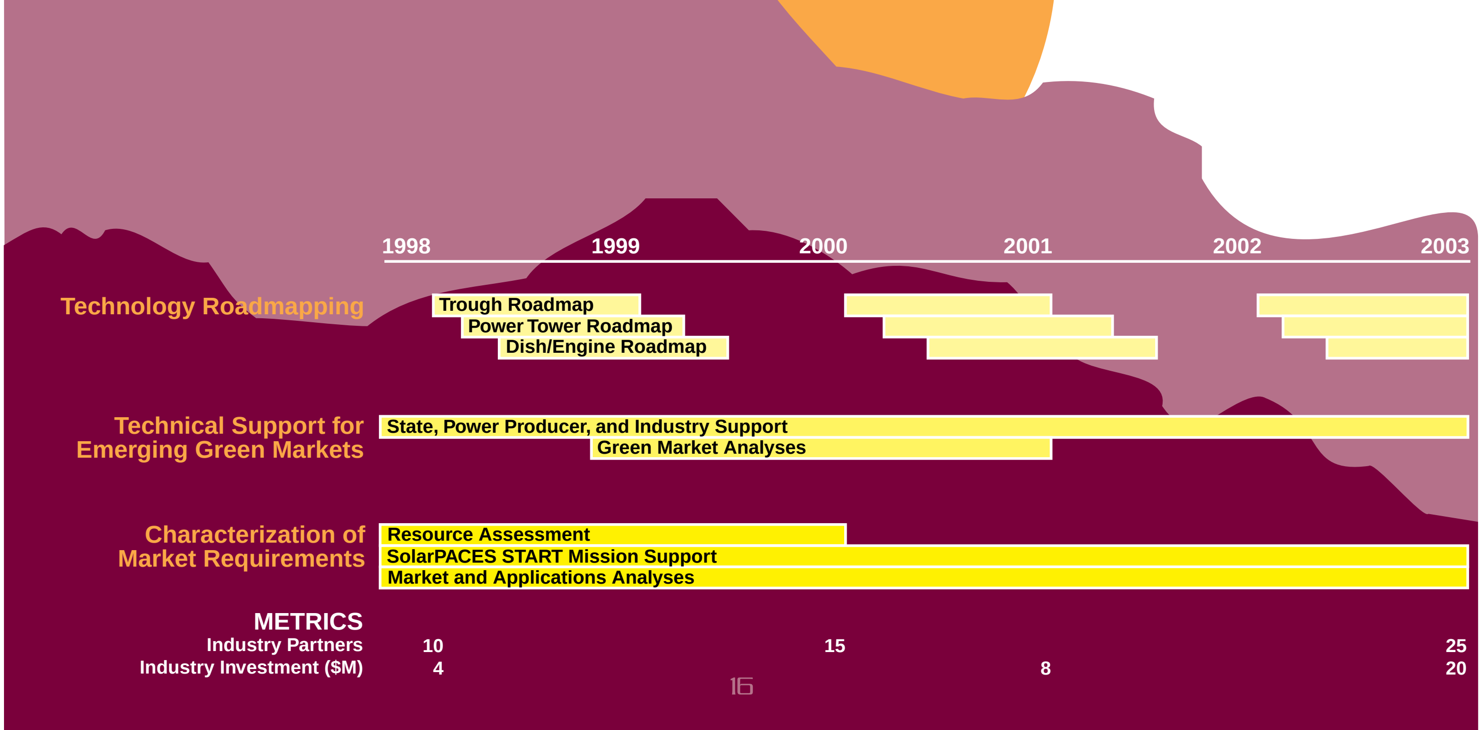
Technology Roadmapping

In this task, we are working collaboratively with industry, end users, and key stakeholders to update our technology development roadmaps. Technology roadmaps are a specific type of planning activity that use market requirements to define specific technical goals and development activities necessary to achieve market success. Technology roadmaps are specific to both the market application and the technology (e.g., troughs, power towers, or dish/engine systems).

During fiscal year 1998, we will develop updated technology roadmaps for parabolic trough systems, parabolic dish systems, and power tower systems that reflect the current status of the technology and changes in energy markets. These roadmapping efforts will be continually updated to support decisions on the direction of the Concentrating Solar Power Program.

Technical Support for Emerging Green Markets

We will provide technical support to stakeholders in developing and evaluating the emergence of green markets and international opportunities. This technical support will involve understanding the drivers for green markets and their effect on states, power producers, and the CSP industry. Our specific activities will include supporting DOE and the states in implementing green markets through their participation in the decision-making process. The potential for international opportunities with CSP systems is very large, and we will continue our involvement in the International Energy Agency/Solar Power and Chemical Energy Systems (SolarPACES) Program to keep abreast of international technology developments and markets.



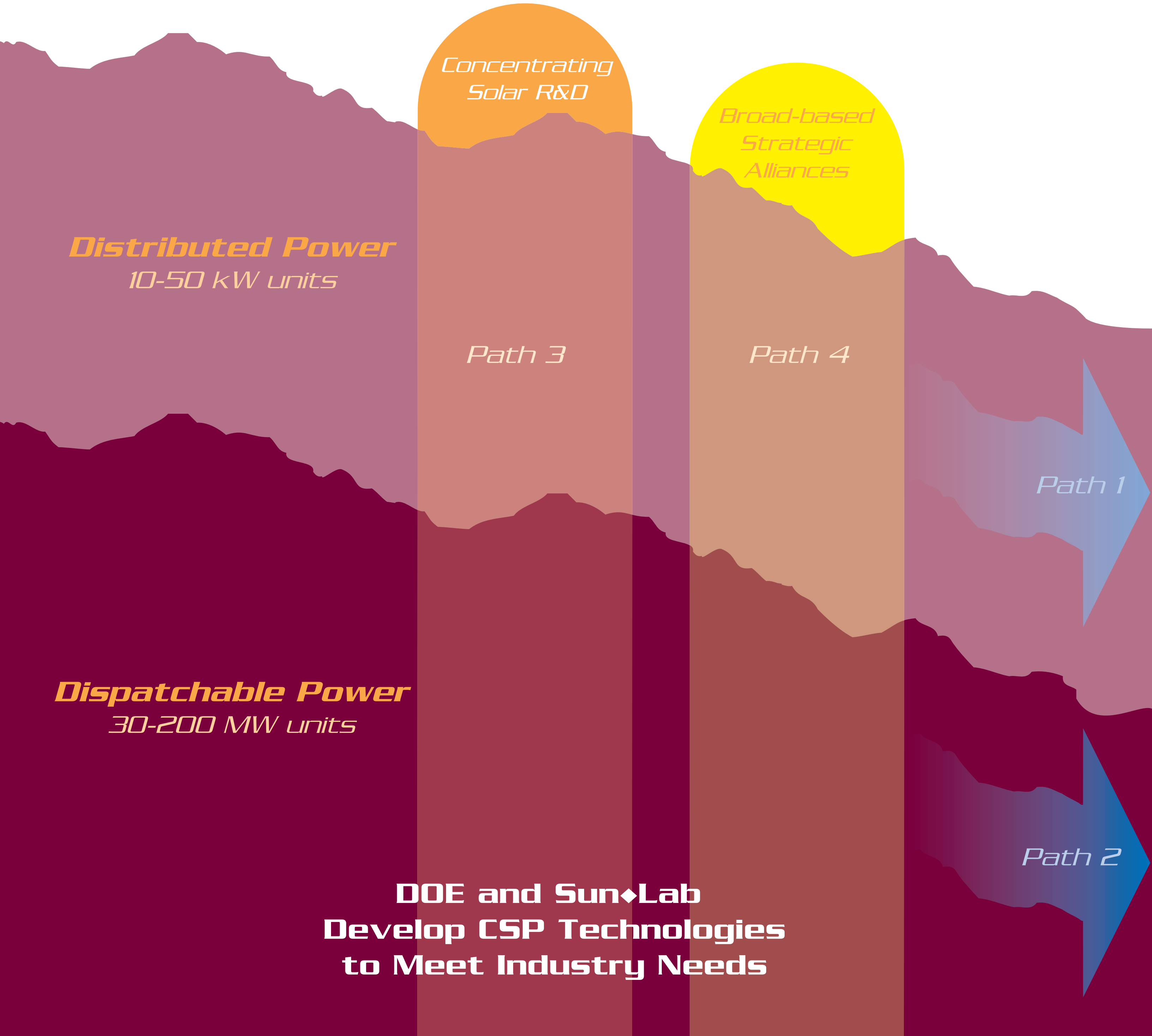
Characterization of Market Requirements

Characterization of market requirements will be an important activity to ensure that viable technology options are being provided to our partners. The current activity used to evaluate alliances and markets for CSP technologies will be developed into a long-term activity to determine directions for the Concentrating Solar Power Program, and this information will be integrated into the technology roadmapping efforts. We will continue to support the SolarPACES START (Solar Thermal Analysis, Review, and Training) Missions that evaluate international opportunities at the request of host countries. Resource assessment will continue to be a key part of understanding where the CSP technologies can be cost effective and to help potential users understand the magnitude of the renewable resource that is available to them. We will also conduct specific application assessment studies (such as village power requirements), as requested.

THE NEXT STEPS

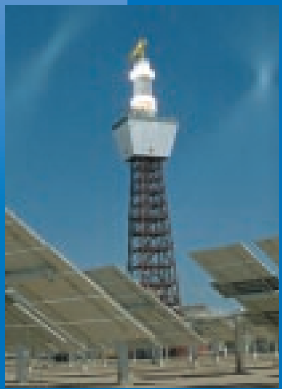
In this plan, we have addressed the research, development, and field validation necessary to make concentrating solar power a viable option in domestic and world power markets. Successful completion of activities from Paths 1 and 2 will ensure these technologies are ready for early, high-value commercial markets. Cross-cutting activities in Paths 3 and 4 will provide for the future advances needed for full competitiveness in global megamarkets and will ensure CSP technologies meet the needs of these markets.

By working closely with U.S. industry in addressing the needs they have identified, meeting the performance metrics we have jointly established, and ensuring effective technology transfer, we at DOE and SunsLab will have fulfilled our commitments to our industry partners. The next steps, implementation of troughs, power towers, and dish/engine systems in the commercial marketplace, will be led by a robust U.S. industry armed with proven, market-ready CSP technologies and capable of large-scale implementation worldwide. Our vision of the future is "world leadership by U.S. industry in serving both distributed and dispatchable power markets with clean CSP technologies."



Commercial Applications of Distributed and Dispatchable CSP Systems are the Result

Industry, with DOE and Sun◆Lab Support, Validates the Technologies in the Field



Industry Takes Over for Commercialization of CSP Technologies

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